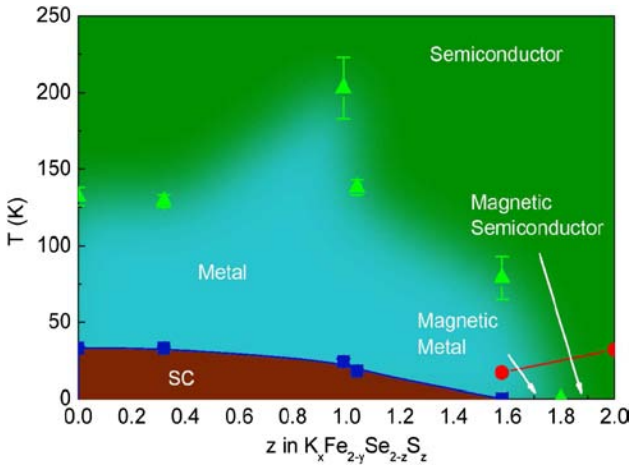
Scientists "Dial In" Superconductivity, Semiconductivity In the Same Material

- Brookhaven National Laboratory scientists studying an iron-based superconductor were able to fully suppress its superconducting state by tweaking its atomic structure, which may open up a new route to understanding and manipulating superconductors.

- The superconductor is composed of potassium (K), iron (Fe), and selenium (Se), and has a layered crystal structure. By substituting sulfur for selenium, a practice called doping, it was tuned from a superconductor at low temperatures to a magnetic semiconductor.

- At NSLS beamline X7B the researchers used x-rays to study how doping affected the crystal structure. They correlated these structural changes with the material's magnetic and electronic properties and critical temperature (the temperature below which it superconducts).



Magnetic and superconducting phase diagram of $K_xFe_{2-y}Se_{2-z}S_z$, showing the critical temperature, T(K), as a function of the degree of sulfur doping (z=0 denotes no sulfur). Green, blue, and orange colors show semiconducting, magnetic, and superconducting regions, respectively.

- The researchers showed that rather small structural changes, particularly around one of the two Fe atoms in the crystal's unit cell, accompanied increased sulfur substitution. This caused a dramatic drop in the material's critical temperature and suppressed superconductivity.

Lei et al., "Phase Diagram of K_x Fe_{2-y} Se_{2-z} S_z and the Suppression of its Superconducting State by an Fe2-Se/S Tetrahedron Distortion," Phys. Rev. Lett., 107, 137002 (2011).